N° 3792 A.D. 1915

Date of Application, 9th Mar., 1915—Accepted, 16th Sept., 1915

COMPLETE SPECIFICATION.

Improvements in Rolling Mills.

I, JOSEPH EDWARD FAWELL, Mechanical Engineer, of 1452, Beechwood Boulevard, Pittsburgh, County of Allegheny, State of Pennsylvania, United States of America, do hereby declare the nature of this Invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention described herein relates to rolling mills where a set of rolls is adjustably mounted in a housing arranged for rotation on stationary supporting frames. Except in the tandem or continuous type of mills, reduction is effected of a plurality of back and forth passes through the mill. These back and forth passes are so effected in mills having a pair of rolls, by rotating the latter first in one direction and then in the opposite direction. This mode of operation involves the employment of reversible motors, which are objectionable for many reasons. These objections are avoided by the use of three high mills, which, however, involves the use of vertically movable feed tables.

In order to avoid the objectionable features pertaining to the two high reversing mills and the three high mills, two pairs of two high mills have been arranged in tandem and the pairs are oppositely driven. When a piece is being reduced by one pair the rolls of the other pair are separated so as to allow the piece to pass between them. This form of mill is objectionable on account of the necessary shifting of one or both pairs intermediate of each reduction and for other reasons.

Another method employed in order to obtain reversal is that of driving a single pair of two high mills in opposite directions and rotating the roll housings through an angle of 180° the resulting transposition of the rolls relative to each other effecting the reverse pass. This invention is an improvement on this method by reducing the angle of rotation of the roll housings and also in other ways to be hereafter described.

The invention described herein has for its object the operation of moving one of the two sets of rolls out of line of movement of an article while being reduced by the other pair, this object being effected by the use of partially rotatable or vertically movable roll housings. The invention and means of carrying it into effect are however more fully described and claimed hereafter.

In the accompanying drawings forming a part of this specification:—

Fig. 1 is a sectional elevation of a mill embodying my improvement, the plane of section being at right angles to the axes of the rolls.

Fig. 2 is a top plan view of the same;

Fig. 3 is a sectional elevation on a plane indicated by the line III—III Fig. 1;

Fig. 4 is an end elevation of the pinion housings and pinion;

[Price 6d.]

Fig. 5 shows in plane and end elevation a modification of the arrangement of the pinions;

Fig. 6 is a sectional elevation illustrating a modification in the manner of mounting the rolls; the plane of section being at right angles to the axes of the rolls;

Fig. 7 is a sectional elevation on a plane indicated by irregular lines VII—VII Fig. 6;

Fig. 8 is an end, and

Fig. 9 a side elevation of a form of pinion housing and pinions which may be employed with the form of mill shown in Fig. 6;

Fig. 10 is a sectional elevation illustrating another form of supporting the pairs of rolls;

Fig. 11 is a side elevation of the construction shown in Fig. 10;

Fig. 12 is a sectional view illustrating another embodiment of my improvement;

Fig. 13 is a diagrammatic view illustrating the preferred arrangement of the driving pinions relative to the rolls;

Fig. 14 is a sectional elevation showing an adaptation of, and accessories for the type of mill indicated in Figs. 1 and 6 for rolling heavy sections;

Fig. 15 is a side elevation of the same;

Fig. 16 is a sectional plan, the plane of section being indicated by the line IV—IV Fig. 14;

Fig. 17 is a top plan view showing the mill illustrated in Fig. 14 and the preferred form of roll operating mechanism;

Fig. 18 is an end view of the pinion housing and pinions shown in Fig. 17;

Fig. 19 is a sectional elevation of the type of mill in which provision is made for shifting the upper rolls to vary the pass dimensions, and

Fig. 20 is a transverse section of the construction shown in Fig. 19.

In the form of mill shown in Figs. 1 to 5 inclusive, two pairs of rolls 1, 1 and 2, 2, have their journals supported by suitable boxes and bearing blocks arranged in the windows of pairs of housings 3, 3 and 4, 4. As clearly shown in Fig. 1, the members of one pair are made integral with the corresponding members of the other pair, but the housings 3, 3 are arranged at an angle in the housings 4, 4. As regards the arrangement of the rolls in the housings and the manner of supporting them therein, any suitable construction may be employed, and while hand operated screws 5 are shown for adjusting the rolls, any other known or suitable means may be employed for that purpose.

These housings are secured on a shaft 6, which is mounted in pillow blocks 7 as shown in Figs. 2 and 3, and on this shaft is secured an arm 8 connected by a rod 9 to a suitable motor, as the fluid pressure cylinder 10, whereby the housings may be shifted as to move one pair of rolls to operative position and the other pair of rolls out of the line of movement of the article being reduced by the first pair.

As shown in Figs. 1 and 2 stationary tables having feed rollers 11 are arranged on opposite sides of the mill. As the movement of the housings prevents the tables being arranged with their inner ends sufficiently near the rolls to prevent the emerging end of the article from dropping down, intermediate supports are provided by arranged rollers 12 on brackets 13 so secured to the housings that when one pair of rolls is moved to operative position, the rollers 12 will be horizontally in line with the rollers 11.

The movements of the housings from one position to the other are preferably arrested by stops 14, against which the housings can be firmly held by the motor. It is preferred that the angle between the housings 3 and 4, which will be dependent to some degree upon the diameters of the rolls, should be such that when one pair of rolls as 2, is in operative position, the upper roll of the other pair will be in a position to serve as a feed roller for the piece being reduced by the first pair. In order to support the end of the piece

while passing from the operating rollers to the roll serving as a feed roller, an idler roller 15 may be arranged on the housings as shown in Fig. 1.

In order to reduce as far as possible the distances between inner ends of the feed tables and the rolls when in operative position, the feed tables or at least the inner ends thereof are made of a width less than the distance between the housings, so that the upper ends of the latter will move alongside of the inner ends of the tables as shown in Fig. 2.

As it is preferred that each of the rolls should be driven directly from a pinion, the necks at one end are connected by sleeves 16 to one end of the coupling shafts 17, and the opposite ends of the latter similarly connected to the necks of the respective pinions. As shown in Figs. 2 and 13, the pairs of pinions 18 and 19 are arranged on opposite sides of a vertical plane *a* coinciding with the axes of a pair of rolls when in operative position, and in order that the angles of the coupling shafts 17 with the axes of the rolls will be equal when the latter are in operative and inoperative positions, the pinions are so arranged in their housings, that planes *b c* coincident with the axes of the respective pairs of pinions will form angles with the vertical plane *a* approximately one-half of the angle formed by the planes coincident with the axes of the pairs of rolls as will be clearly seen by reference to Fig. 13.

As shown in Figs. 2 and 4, uniformity of rotation of the pairs of rolls may be attained by arranging intermeshing pinions 20 on extensions of the shafts of the lower pinions of the pairs 18 and 19, power being applied to one of said shafts. Or if preferred the pairs of pinions 18 and 19 may be arranged in such relation to each other that the lower pinions of each pair will intermesh as shown in Fig. 5.

In the construction shown in Figs. 6 to 8 inclusive the pairs of rolls 1 and 2 are shown as having their journals 21 mounted in suitable bearings in circular housings or discs 22, which in turn are mounted in annular bearings 23. As shown in Fig. 6, the pairs of rolls are so arranged relative one to the other that planes coincident with the axes of the rolls of each pair will be at an angle to each other dependent upon the diameters of the rolls. The circular housings may be shifted by any suitable means, as for example by pinions 24 intermeshing with teeth on the peripheries of the housings and also with the toothed bars 25, which can be shifted by any suitable motor as the fluid pressure cylinders 26. The pairs of rolls are connected to pairs of pinions 27 and 28 as by coupling shafts 29. As described in connection with the construction shown in Figs. 1 to 5, the pairs of pinions are arranged relative to the rolls and to each other, so that the angles of the coupling shafts with the rolls will be the same or approximately so, when the rollers are in either position.

In the construction shown in Figs. 10 and 11 the housings 30 carrying the pairs of rolls 1 and 2 may be suspended from a shaft 31, supported on pillars 32 and 33, one of which may be an extension of one side of the pinion housing 34 as shown in Fig. 11. A pendulum-like movement is imparted to the housings to bring the respective pairs of rolls to operative positions by a motor 35 connected to extensions of the housings.

In lieu of moving the pairs of rolls in arcs of circles a rectilinear movement may be given to the housing carrying the pairs of rolls as shown in Fig. 12. The housings 36 and 37 are movably mounted in a frame 38, so as to be moved vertically to and from operative position. In the construction shown, the housings rest upon rods 39 connected to opposite ends of a lever 40, which is provided on arm 41 connected to the motor 42.

It is characteristic of the improvement described herein that as one pair of rolls is shifted to operative position relative to line of feed of the metal, the other pair of rolls is moved to a position where it will not interfere with the movement of the metal from the other pair. As the pairs of rolls are rotated

to effect respectively opposite movements of the metal being reduced, the top roll of one pair will rotate in the same direction as the bottom roll of the other pair, and hence if in moving a pair to inoperative position, such movement be checked when the upper roll of the pair has reached a position, where its upper surface will be in the plane of the upper surfaces of the feed rollers, such roll will operate to feed the metal along.

While mounting the housings carrying the pairs of rolls on a rotatable shaft as shown and described in Figs. 1 and 3 is suitable for small mills having the moving parts comparatively light and in which the strains incident to rolling are not excessive, it is preferred when adapting my improvements to blooming and other mills for rolling large sections to employ the embodiments of the invention shown in Figs. 14 to 20 inclusive.

It is preferred in constructing mills for rolling heavy sections to employ modifications of the constructions shown in Figs. 1 and 6, and to this end the lower ends of the housings 4 are formed on arcs of circles and rest upon rollers 42 suitably mounted on the bed of the mill, as shown in Figs. 14, 19 and 20. The two sides of the housing are drawn together against opposite ends of spacing blocks 44 by bolts or tie-rods 45. The lower blocks 44 having formed thereon a lug 46 to which are secured the inner ends of rods or pitmen 47 and 48 as shown in Figs. 14 and 16. The outer ends of the pitmen are secured to cross-heads 49 and 50 carried by the rams or pistons 51 and 52 of fluid-pressure cylinders 53 and 54 oppositely arranged on the bed plate of the mill. By the admission of fluid pressure into these cylinders alternately, tension will be applied to the rods of pitmen 47 and 48 to rock the housing first in one direction and then in the opposite direction. The respective oscillations of the housings are limited by means of stops 55 56 carried by the housings encountering abutments 57 and 58 on the bed of the mill. The stops may be constructed and arranged in any suitable manner, but are preferably formed by lateral extensions of the lower spacing block 44 to which the pull rods or pitmen 47 and 48 are connected as shown in Fig. 14.

As the weight of the housings and rolls are considerable and would acquire considerable momentum when being shifted, suitable means should be employed to gradually reduce the rate of movement as the stops approach the abutments. Any form of elastic cushion may be employed as for example in the construction shown, cylinders 59 and 60 having their inner ends closed are so arranged on the bed of the mill that their pistons 61 can be connected to the cross-heads 49 and 50 as shown in Fig. 16. When fluid pressure is admitted into the cylinders 53 to shift the housings, the cross-head 50 will be drawn to the left forcing the pistons 61 into the cylinders 60 compressing the air contained therein. In order that these cushioning devices may not interfere materially with the movement of the housings until near the end of their movement, a series of outlet ports 62 are so formed in the cylinders as to be progressively closed by the pistons as they move inwardly. As the last of these ports will be closed before the housings have reached the end of their movement a valved outlet is provided to control the final rate of movement of the housings. As it is desirable that the resistance of both cushioning cylinders should be equal, their inner ends are connected by pipes 63 which are provided with outlet valves 64. By proper adjustment of these valves, the contact of the stops with the abutments will be attended with very little shock or jar.

In Fig. 14, the stop 56 is in engagement with the abutment 58, so that by maintaining pressure in the shifting cylinder 54, the housing will be held firmly in the position shown. A similar locking of the housing on the opposite position will be effected by maintaining pressure in the cylinder 53 after the housing has been shifted. Thus by the conjoint action of the stops, abutments and shifting cylinders, the housings are rigidly secured to the mill bed, when the mill is in operation and subjected to strains tending to unseat

the housings. While it is probable that the weight of the housings and rolls will be amply sufficient to prevent any unseating of the housing while being shifted, retaining lugs may be so secured to the millbed as to engage curved flanges adjacent to the lower ends of the housing.

Suitable means should be employed to support the housings laterally, and while not necessary it is preferred that these lateral supports should be of a character that will not permit of the free lateral movement of the housings and will not be liable to injury by scale, *etc.* In the construction shown these supports consist of rollers 68 so secured in the mill bed as to bear on curved surfaces 67 on the housings as shown in Fig. 15. The housings are provided with windows for the reception of the boxes or bearing blocks for the journals of the rolls. These windows are closed at their tops, by removable caps 69 through which pass the screws 70 for adjusting the upper roll to compensate for wear. The upper rolls are yieldingly held against the screws by springs 71 surrounding the upper ends of rods 72 which are connected to the saddles 73 carrying the journals of the upper rolls.

In constructing mills in which the relation of the upper and lower rolls are not changed except to compensate for wear, the windows in the housings are preferably arranged at such an angle one to the other, that when one pair of rolls as *c—d* are in operative position as shown in Fig. 14, an article passing through between these rolls will pass over and preferably in contact with the roll *a* of the other pair, so that this roll, which rotates reversely to the roll *c* will act in conjunction with the feed rollers 74 to carry the article along. Fore plates 75—76 are so secured to the housings to bridge the spaces between the respective pairs of rolls and the inner ends of the feed tables A and B which are provided with reversible feed rollers 74. In order to carry the article from the top rolls when the latter are operating to feed, to the inner end of the receiving table bridge pieces 77 are secured to the housings, said bridge pieces being adapted to operate as strippers to prevent a piece from being caught in grooves in the upper roll.

It is the general practice to employ strippers in connection with grooved rolls to prevent the entering end of an article being carried around the lower roll and similar means are employed in my improved mill. The strippers 78 and 79 are preferably made integral one with the other and are so constructed as not only to serve as strippers but also to support the article intermediate the reducing pair of rolls and the top roll of the other pair.

As will be readily understood by those skilled in the art, the upper rolls cannot be employed to feed the article in place, blooming and other mills in which the dimensions of the pass have to be varied by the shifting of the upper roll, and hence in that type of mill provision should be made for carrying the article from the bite of the rolls in operating position over the other or non-working pair of rolls to the receiving table. Hence in such mills the windows for one pair of rolls should be at such an angle to those for the other pair, that when one pair of rolls is in working position; the top roll of the other or non-working pair will even when shifted to the maximum distance from its lower roll, be substantially below a horizontal plane tangential to the top of the lower roll of the pair in working position as shown in Fig. 19. When the mill is in the position shown in Fig. 19 the rolls *c—d* are in working position, and in order to carry the article from feed table B to rolls, supports 80^b are arranged in front or on the feed side of these rolls, said supports being preferably in the form of a roller having its journals mounted on suitable bearings on the housings. A similar support 80^a is arranged in front of the other pair of rolls *a b*. In order to carry the article from the rolls *c—d* to feed table A, two or more feed rollers 84, reversible but non-shiftable with the rolls, will be arranged intermediate of the latter as shown in Figs. 19 and 20, these rollers have their journals mounted in the side pieces 85 connected by

cross-bars 86, and provided with trunnions 87 and 88. The trunnion 87 is made circular in cross-section and extends into a bearing in one of the housings, but the other trunnion 88 extends through the other housing and has its outer end secured in an anchorage 89. As the axes of the trunnions coincide with the axes of movement of the housings and as one of the trunnions is held stationary by the anchor the housings can be shifted without affecting the position of these intermediate supports. As the feed tables A and B are vertically stationary and have their rollers tangential to a common horizontal plane, the rollers 84 are so mounted in the side pieces, as to be tangential to the same plane, which passes between the rolls of each pair when in working position. Provision is made for rotating one or more of the intermediate feed rollers by extending the journal of one of the rollers through the trunnion 88 and securing a bevel pinion 91 on this extension 90. This pinion is driven by a corresponding pinion on a shaft 92, which can be connected with the mechanism employed for operating the rollers of tables A and B, so as to be driven in the same direction as said rollers.

In lieu of the arrangement of transmitting pinions shown in Figs. 8, 9 and 13, where planes passing through the axes of pinions are at an angle one to the other, it is preferred to employ the arrangement shown in Figs. 17 and 18.

As the pairs of rolls do not in any sense form a continuous train, they may be driven independently one of the other and at different rates, but it is preferred to drive them from a common motor through suitable housings as shown in Fig. 17. The rolls of each pair are connected by universal couplings 16 to one end of driving spindles or coupling shafts 17 which have their opposite ends similarly connected to the journals of pinions 18, 18^a and 19, 19^a. The pinions of each pair which are arranged in a common vertical plane intermesh so that the rolls driven thereby will rotate in opposite direction and the shafts carrying respectively one pinion of each pair (the upper pinions in the construction shown) are extended and have secured thereon gear wheels 20 which intermesh so that the rolls of one pair will rotate in a reverse direction to those of the other pair. One of the gear wheels 20 is operatively connected to the motor shaft.

In the type of mill shown herein, provision is made for varying the relative positions of the rolls of each pair by means of screws 92 passing through the caps 69 of the housing in which the roll journals are mounted. As it is preferred that the screws for each pair should be shifted simultaneously, the nuts 93 engaging the screws are provided with worm wheels 94, which are engaged by worms on the shaft 95 arranged parallel with the rolls as shown in Figs. 17 and 19. It is preferred that the shafts 95 should be driven by independent motors 96 which may be of any suitable construction. The upper rolls may be held in operative relation to the shifting screws by any of the means known in the art, as for example in the manner shown in Fig. 19, the screws having a swivel connection with the upper bearing blocks 97 for the journals of the rolls and the lower blocks or saddles as they are usually termed being bolted to the upper blocks.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A rolling mill, comprising in combination two sets of rolls mounted in housings adapted to be moved, and means for moving them so as to put one set of rolls into, and the other set out of operative relation to a common line of feed.

2. A rolling mill, as set forth in Claim 1, wherein said sets of rolls are shifted simultaneously to exchange operative and idle positions.

3. A rolling mill, as set forth in Claim 1, wherein the axes of the rolls of

one set are arranged in a plane at an angle to a plane coincident to the axes of the rolls of the other set.

4. A rolling mill as set forth in Claims 1 and 3, wherein the angular relation of said sets of rolls is such that when one set of rolls is in operative relation to the metal the upper roll of the other set will be in the same horizontal plane with the lower roll of said first named set.

5. In a rolling mill, as set forth in Claim 1, housings provided with windows arranged at an angle one to the other, a pivotal support for said housings and means for oscillating said housings.

6. In a rolling mill, as set forth in Claim 1, means for rotating said sets of rolls in opposite directions, said means comprising two sets of pinions and universal driving connection with the respective rollers.

7. A rolling mill, as set forth in Claims 1, 3 and 6, wherein the axes of one set of pinions are in a plane at an angle to a plane coincident with the axes of the other set, the angle made by the plane coincident with the axes of one set with the vertical plane being such that when their corresponding set of rolls is in operative position the angle made by a plane coincident with the axes of the rolls with a plane coincident with the axes of the pinions is equal to that similarly made when said rolls are in inoperative position.

8. In a rolling mill, as set forth in Claim 1, feed tables and movable means for supporting the metal intermediate the rolls and the feed tables.

9. A rolling mill, as set forth in Claims 1 and 8, wherein the inner ends of the feed table are of a width less than the distance between the housings so that the upper ends of the latter are guided by said inner ends of the feed tables.

10. In a rolling mill, as set forth in Claim 1, having housings for the rolls, fluid pressure motors having their rams or pistons connected to said housing and stops for limiting the movement of the housings.

11. A rolling mill, as set forth in Claims 1 and 10, wherein said housings are moved in the arc of a circle to bring the sets of rolls into operative or idle positions respectively.

12. In a rolling mill, as set forth in Claims 1 and 8, two sets of rolls adapted to be shifted vertically to and from operative relation to the feed table, and means for shifting said rolls.

13. In a rolling mill, as set forth in Claim 1, circular housings provided with windows arranged at an angle one to the other, annular bearings for said housings and means for oscillating the housings.

14. In a rolling mill, as set forth in Claims 1 and 13, a plurality of pitmen secured to the housings and motor controlled cross heads on both sides of the housings connecting respective pitmen.

15. In a rolling mill, as set forth in Claims 1 and 13, a plurality of cushioning devices for checking the movement of the housings.

16. In a rolling mill, as set forth in Claims 1, 13 and 15, means for eliminating the influence of said cushioning devices during the beginning of the movement of said housings.

17. In a rolling mill, as set forth in Claims 1, 13, 15 and 16, means for equalizing the dampening effect of co-operating cushioning devices at the end of the movement of said housings.

18. In a rolling mill, as set forth in Claims 1 and 13, means for supporting the housings laterally, said means comprising rollers bearing on curved surfaces on the housings.

19. In a rolling mill, as set forth in Claims 1 and 13, strippers for the lower rolls of each pair, substantially as and for the purpose set forth.

20. In a rolling mill, as set forth in Claims 1 and 13, means intermediate said sets of rolls for moving the article being reduced from the rolls in working position.

21. In a rolling mill, as set forth in Claims 1 and 13, means for carrying

the article being reduced from the rolls in working position over the rolls in inoperative position.

22. A rolling mill, substantially as described and shown, and for the purpose set forth.

Dated this 9th day of March, 1915.

HERON ROGERS & DEHN,
Agents for the Applicant,
Broad Sanctuary Chambers, Westminster, S.W.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

FIG.1.

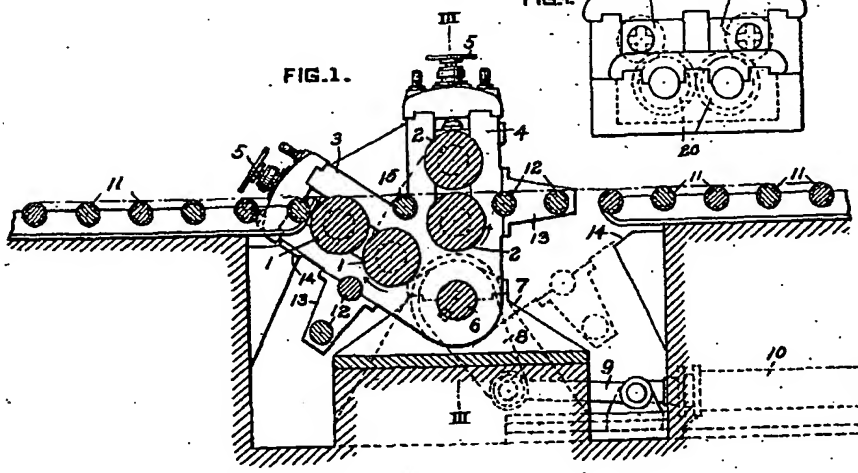


FIG.4.

FIG.2.

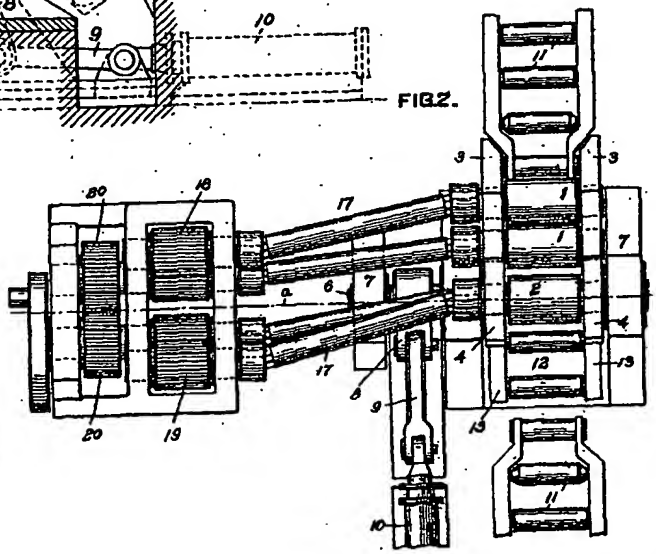


FIG.8.

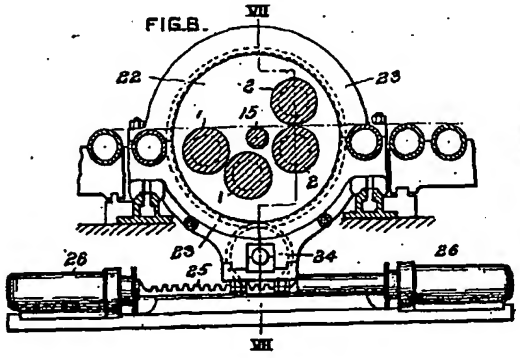


FIG.1.

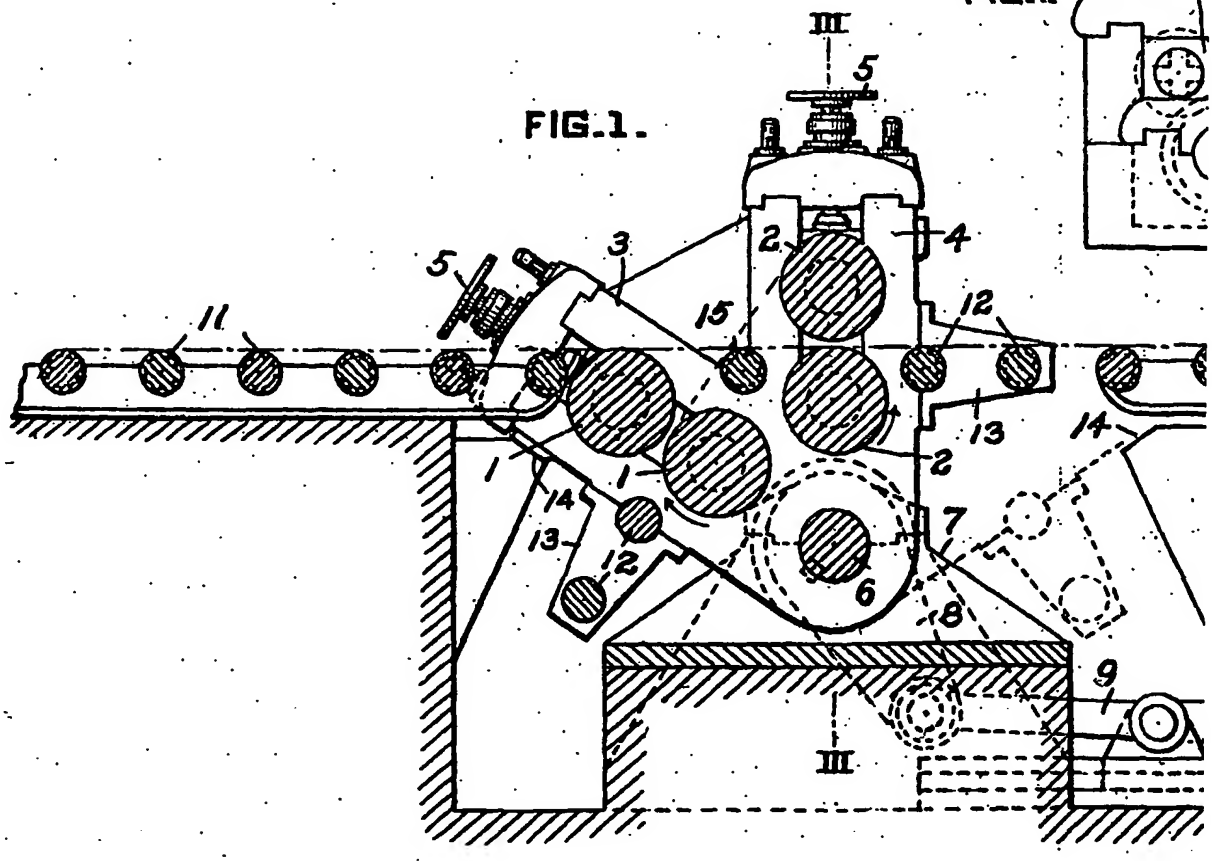
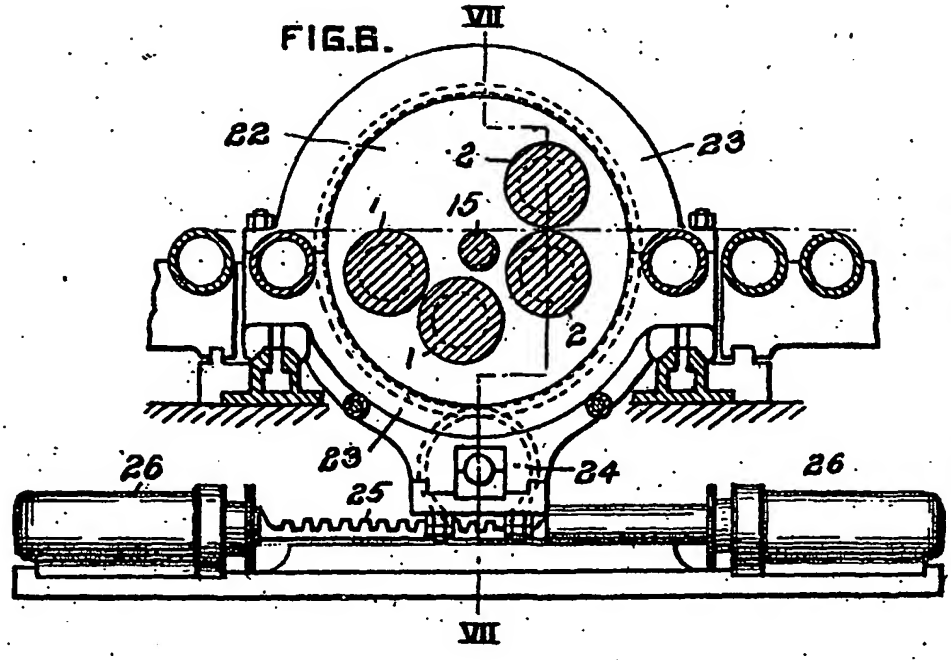
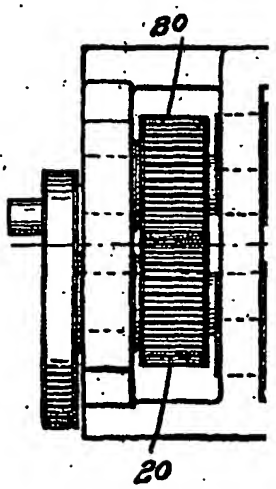


FIG.4.

FIG.6.





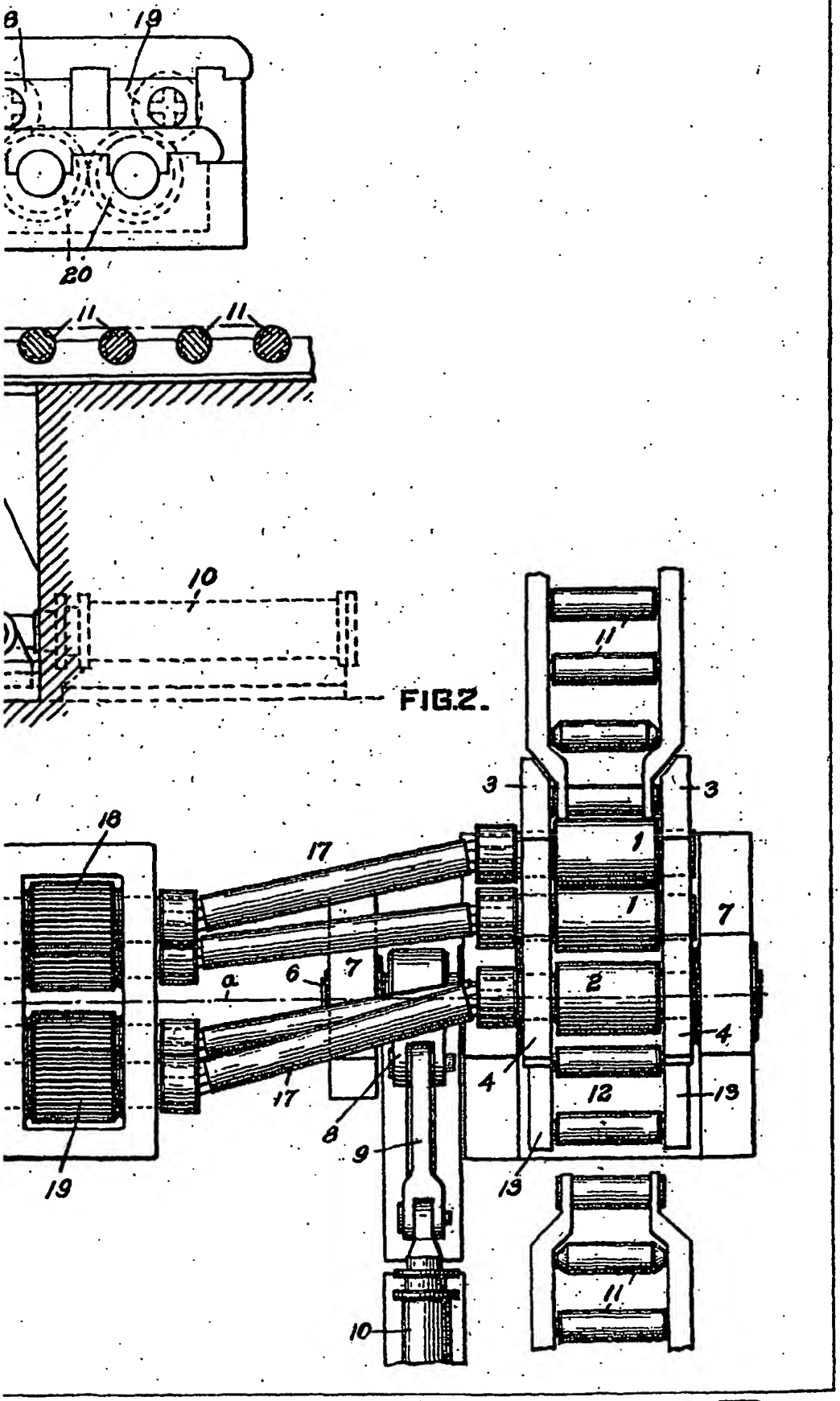


FIG.2.

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG.3.

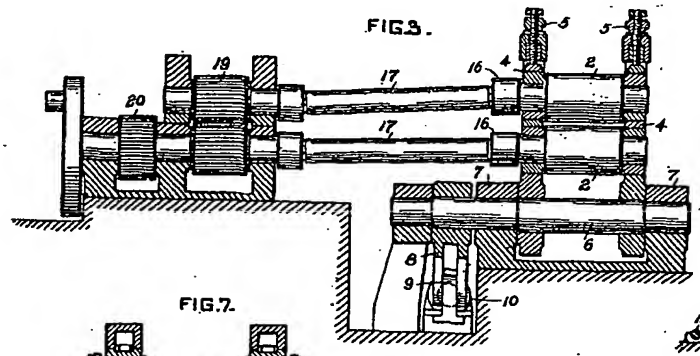


FIG.11.

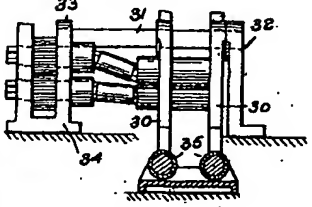


FIG.7.

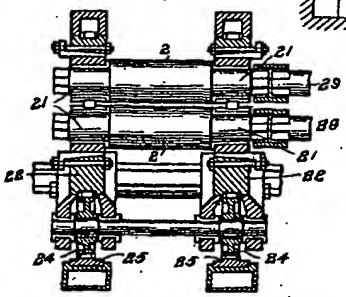


FIG.8.

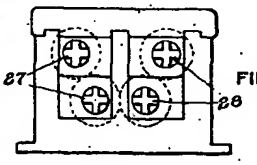


FIG.12.

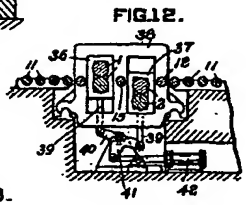


FIG.13.

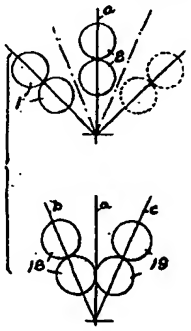


FIG.10.

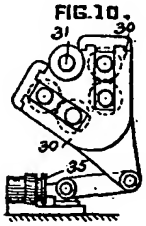


FIG.9.

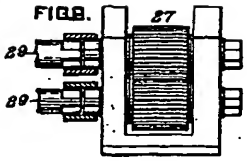


FIG.3.

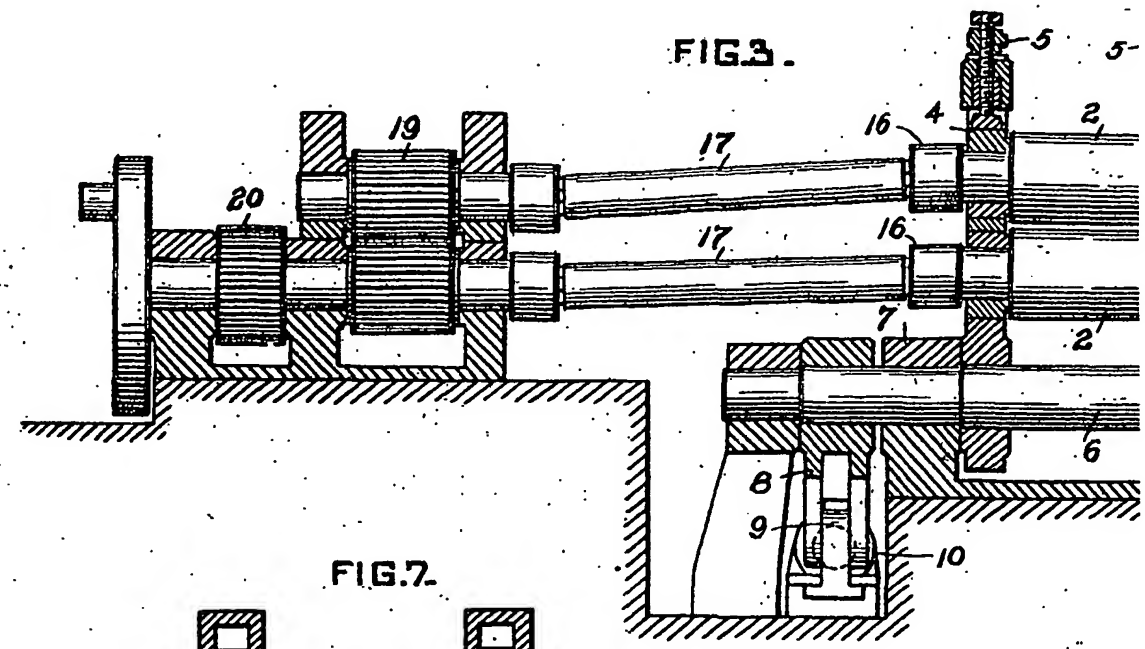
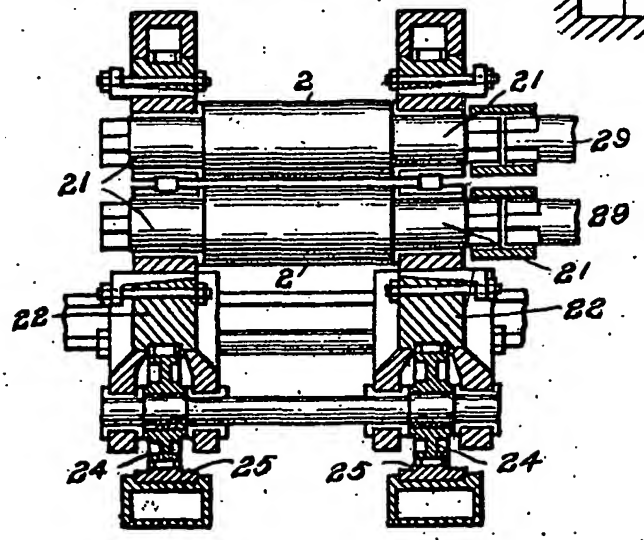


FIG.7.



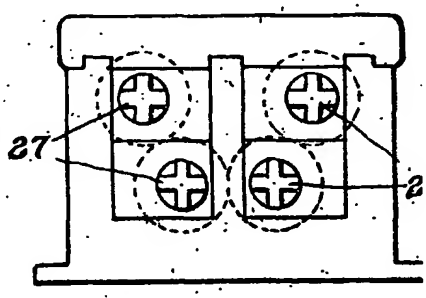


FIG.10.

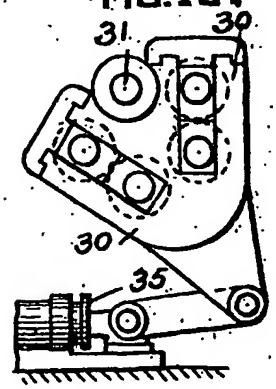


FIG.9.

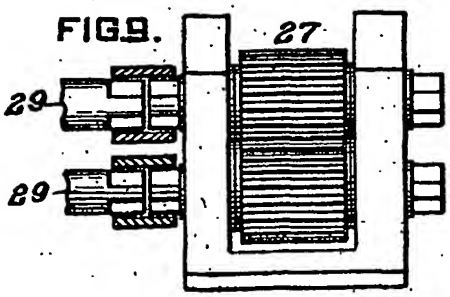


FIG. 11.

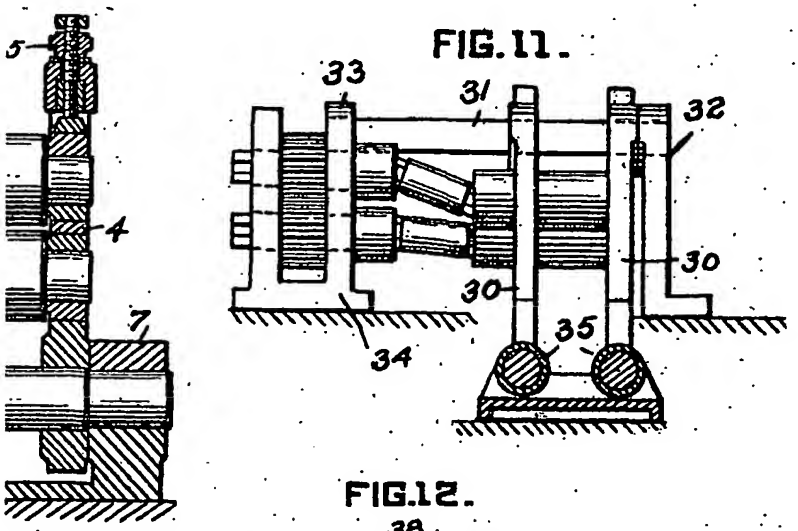


FIG. 12.

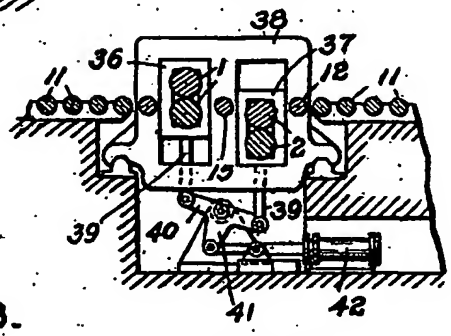
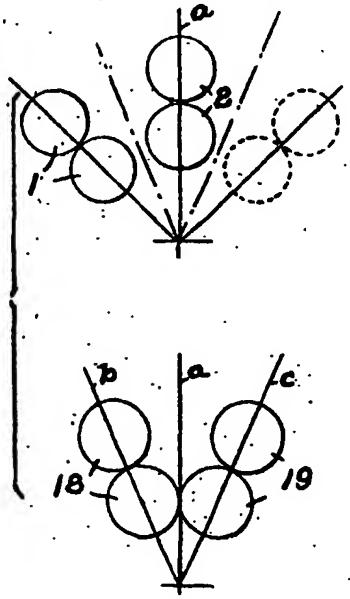


FIG. 8.

28

FIG. 13.



Malby & Sons, Photo-Litho.

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG.14.

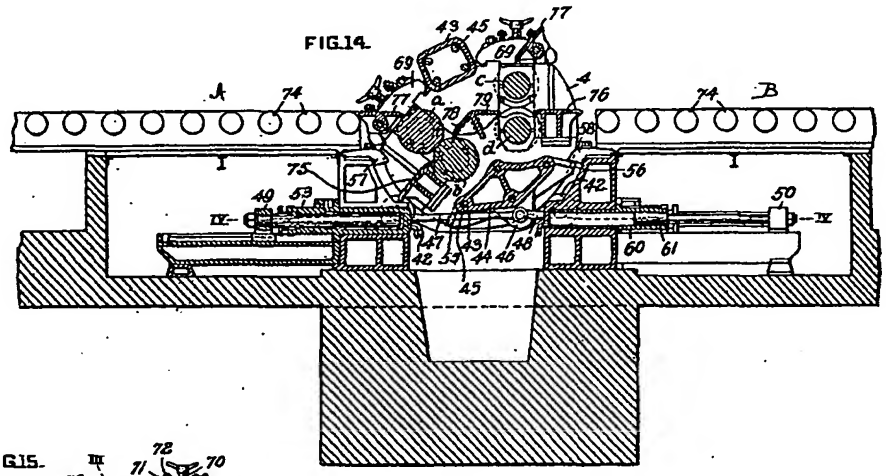


FIG.15.

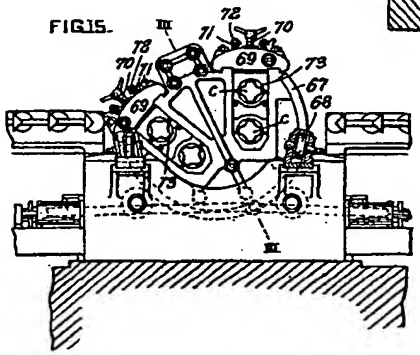


FIG.16.

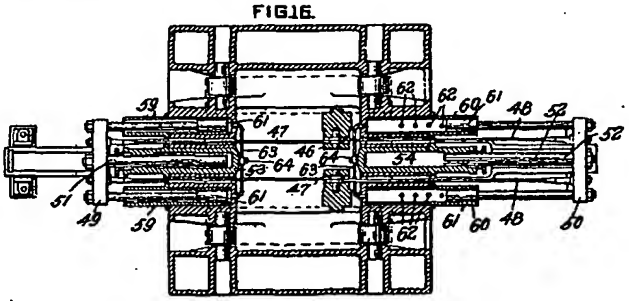


FIG.14.

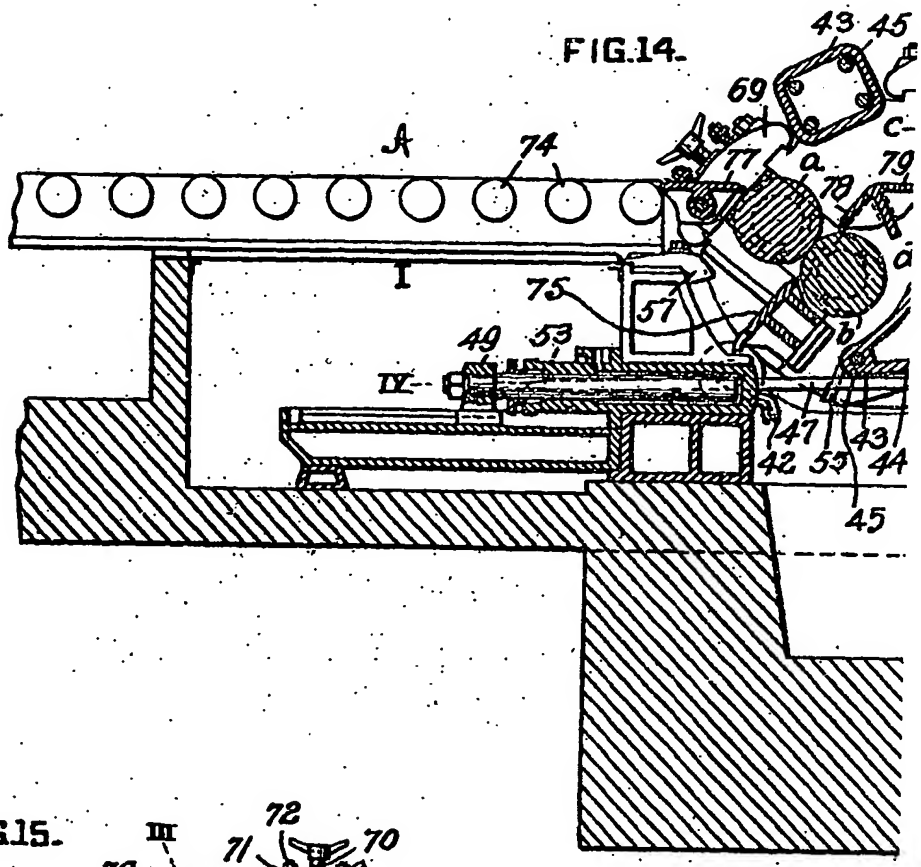
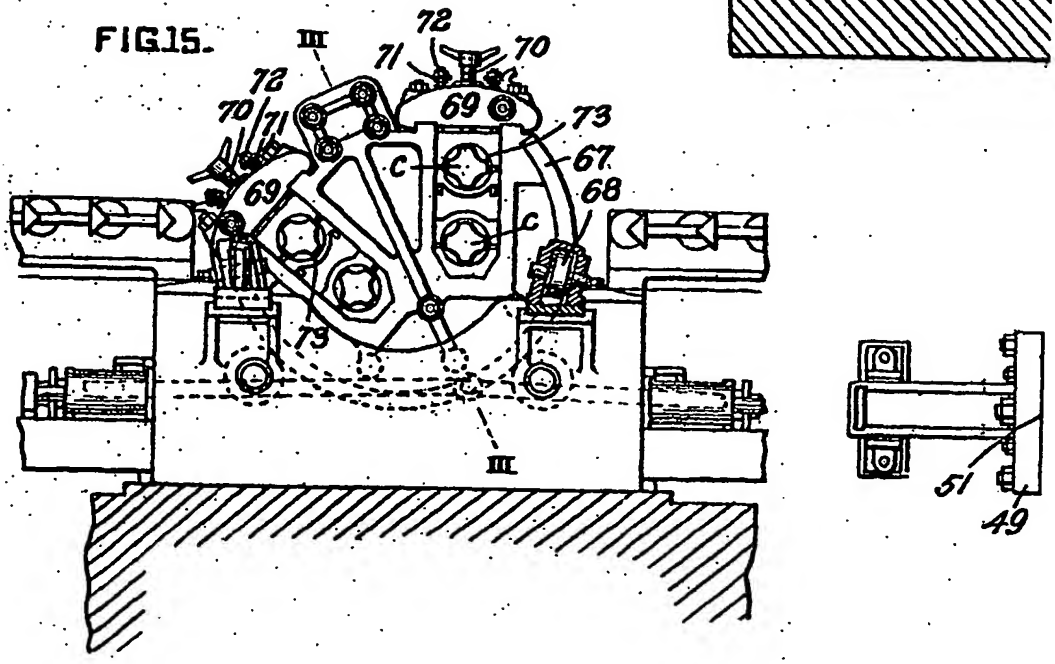


FIG.15.



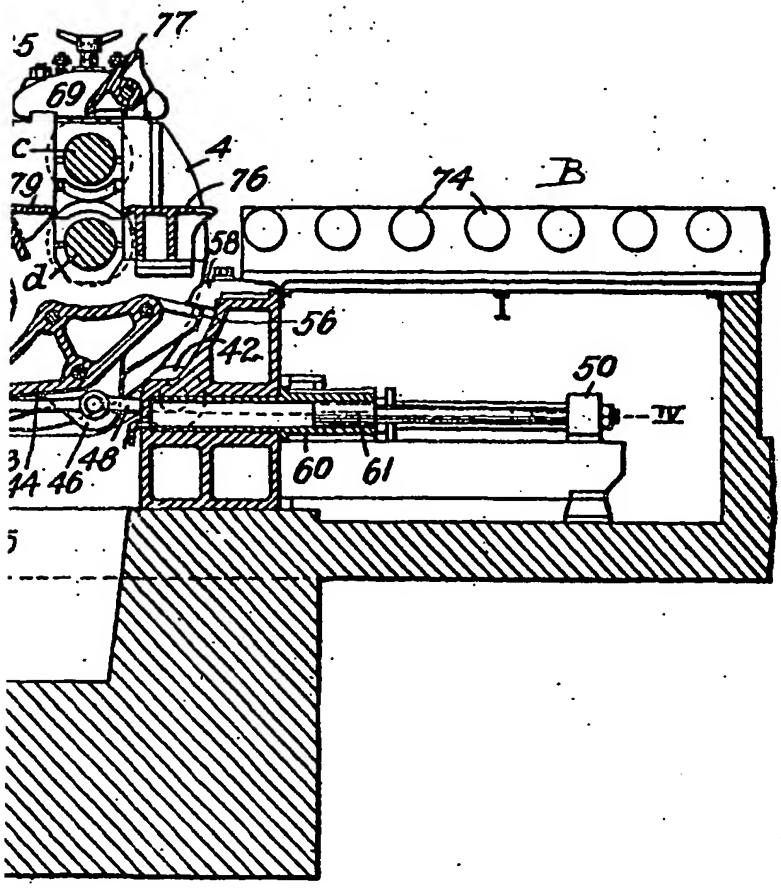
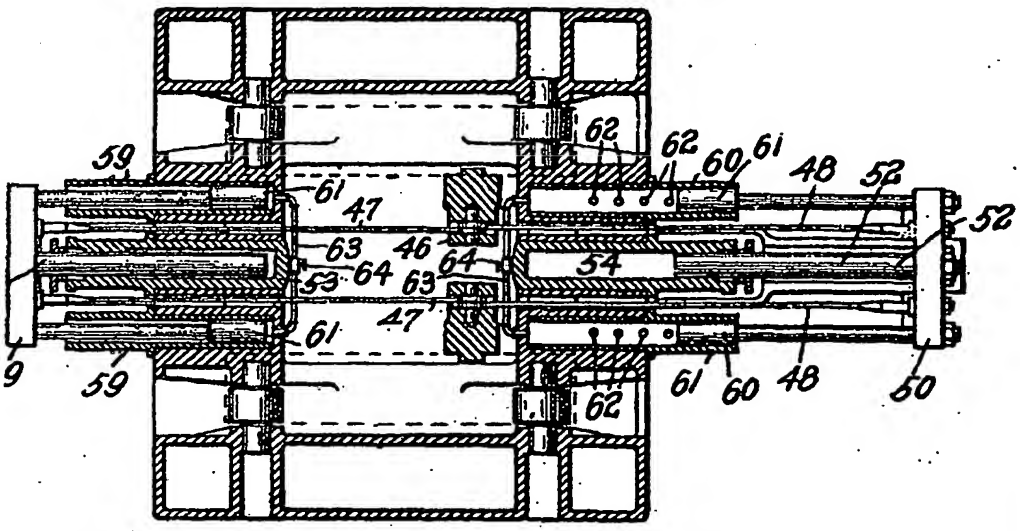


FIG.16.



A.D. 1915 March 9. N° 3791.
FAWELL'S Complete Specification.

(4 sheets) Sheet 4.

FIG.17.

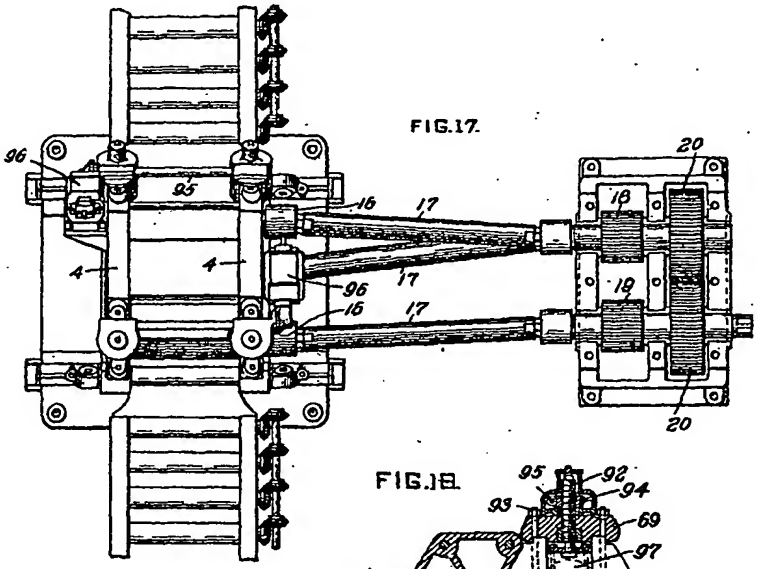


FIG.18.

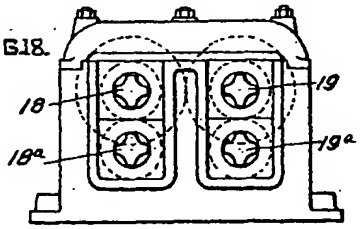


FIG.19.

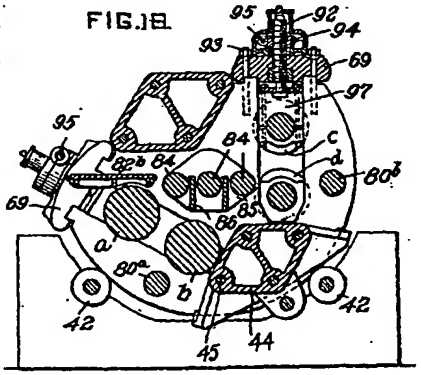


FIG20.

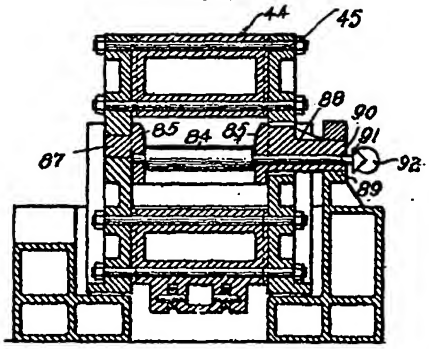


FIG.17.

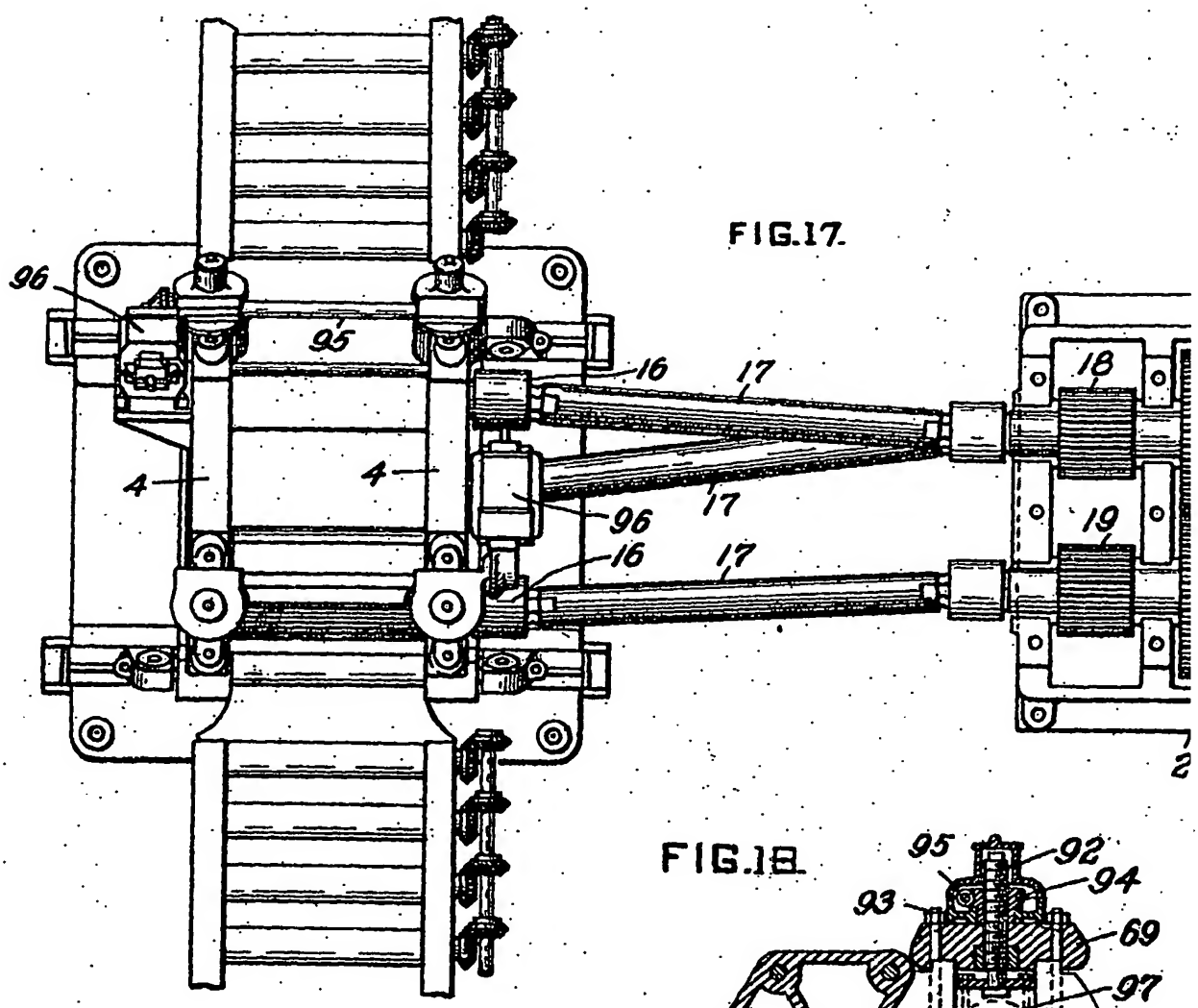
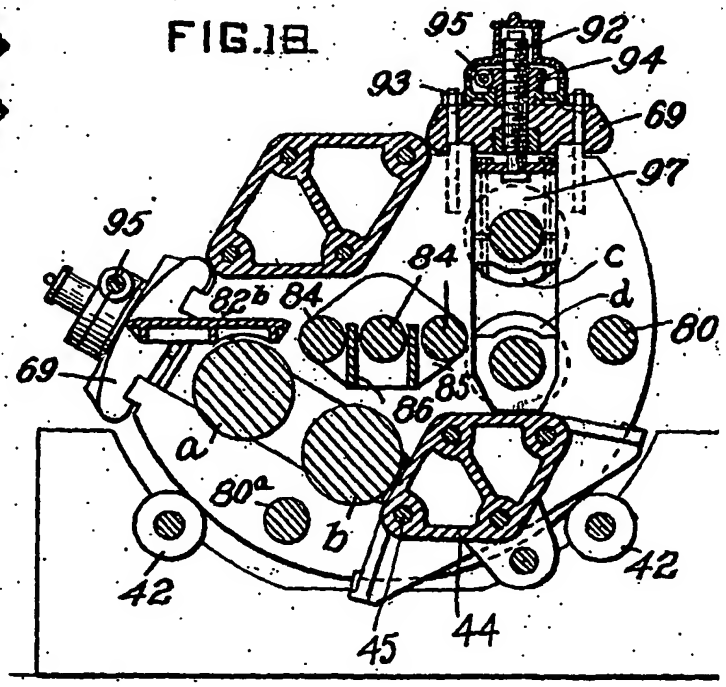


FIG.18.



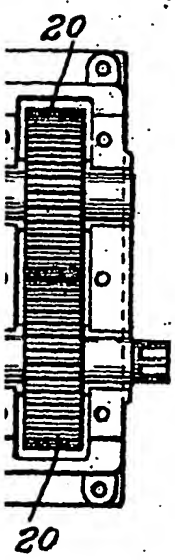


FIG18.

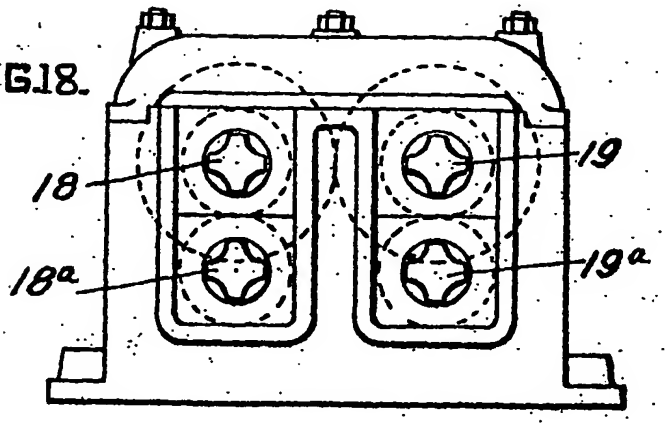
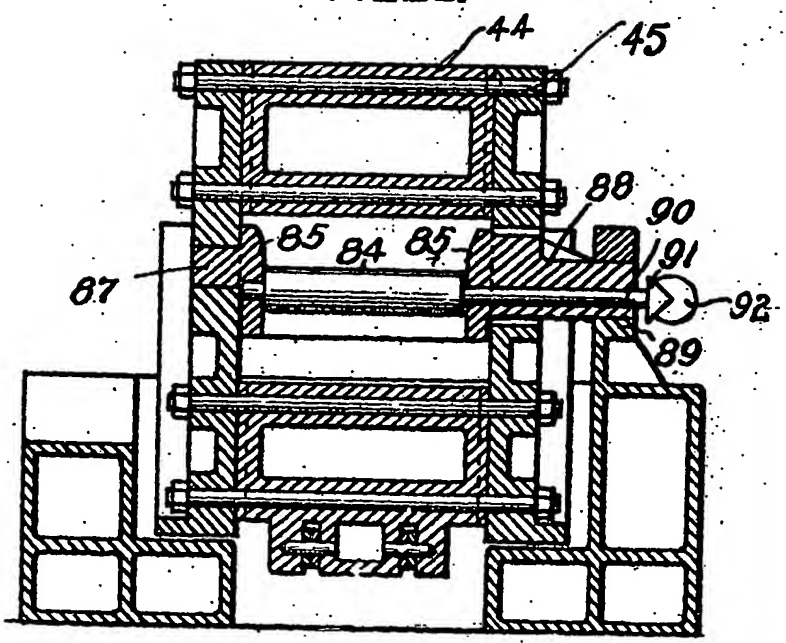


FIG20.



[This Drawing is a full-size reproduction of the Original.]

FIG.5.